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(54) Heat-shielded spark plug boot assembly.

(57) A heat-shielded spark plug boot assembly (10) for an ignition cable connector (16) comprises an L-shaped tubular, elastomeric boot (12) having a cable end portion (40) for receiving an ignition cable (14), a seal end portion (44) for receiving a spark plug (22) and sealing around its outer insulated part (28), and an intermediate cavity portion (42) for housing a terminal (16) for connection with the spark plug (22). An L-shaped heat shield (20) is stamped from flat sheet-metal stock and is then bent and formed to provide a pair of spaced-apart, generally parallel L-shaped sides (50,52), a top side (54) having an inwardly-indented semi-circular upper end (56) and with the sides (50,52) at the upper ends (50a,52a) thereof being rolled on the semi-circular upper end (56) of the top side (54) and towards and into engagement with each other to form a semi-circle (70) and a longitudinal seam (72) at the free edges thereof. The upper portion (50a) of one side (50) has a tab (80) whose free end is received within a complementary-shaped recess (82) of the other upper end (52a) of the other side (52) so as to interlock the two sides (50,52) together. The boot (12) is assembled to the heat shield (20) by press-fitting the boot (12) therein through an open side of the shield (20) and snapping the boot (12) past a pair of indents (90) on the sides (50,52) of the heat shield (20).

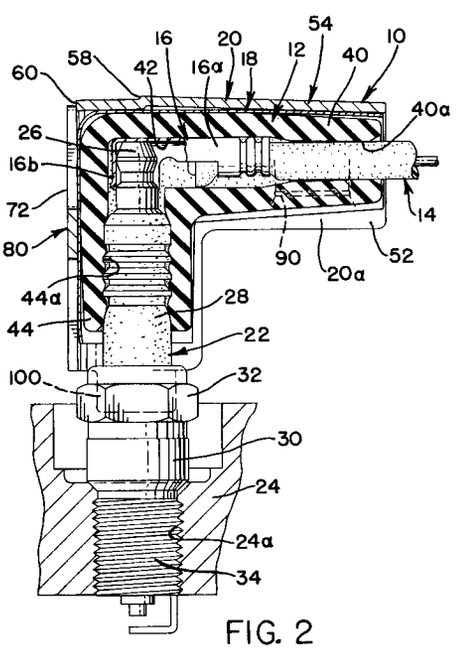

FIG. 2

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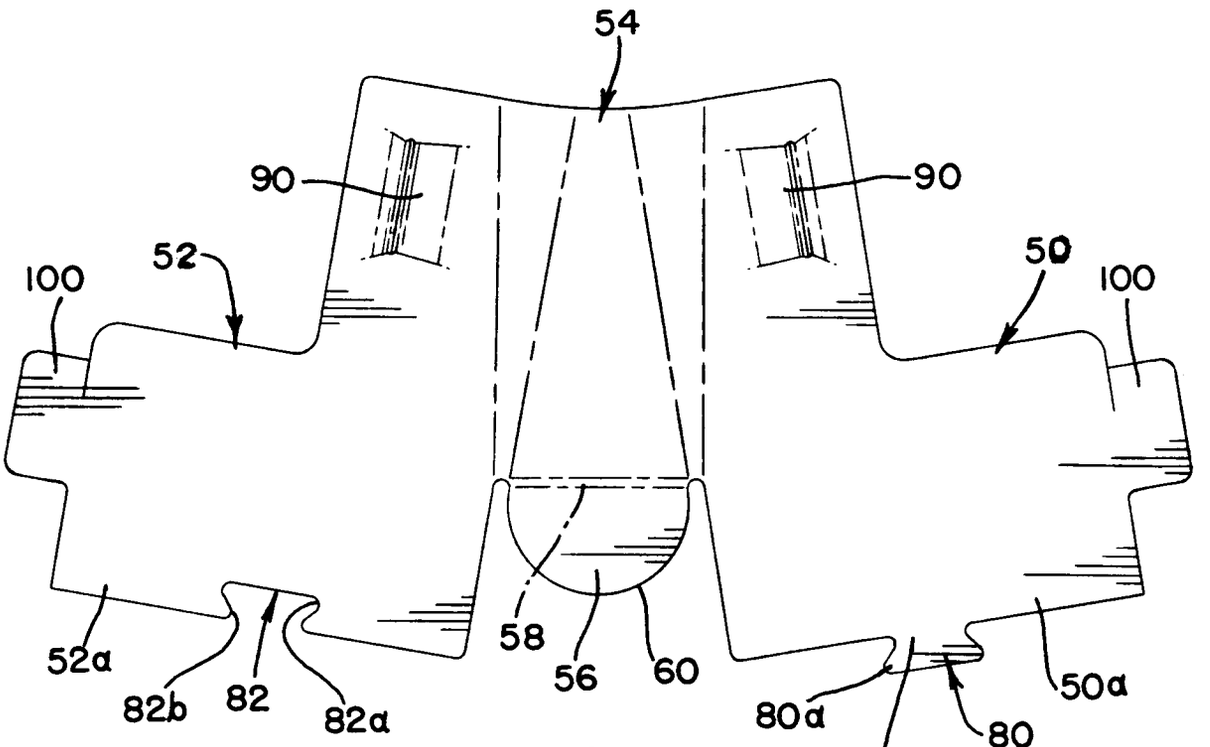

FIG. 6

The present invention relates to an ignition cable connector assembly, and more particularly, to an ignition cable connector assembly having an L-shaped elastomeric boot for housing an ignition terminal and a metal heat shield surrounding the boot and which is adapted to be electrically grounded to a metal shell of a spark plug, according to the preamble of claim 1.

Ignition cable connector assemblies commonly comprise a tubular elastomeric boot having a cable end portion for receiving an ignition cable, an intermediate cavity portion for housing a terminal which is secured to one end of the ignition cable and a seal end portion for receiving a spark plug and sealing around its outer insulator part. These elastomeric boots can either be linear in which the cable end and seal end portions thereof are aligned or be formed so that the cable end portion and seal end portion are either angled or at right angles to each other so as to be L-shaped.

Whilst these ignition cable connector assemblies have been highly successful in use, they can deteriorate or have a shortened useful life when exposed to very high operating temperatures in an engine compartment, since they are often located near the engine exhaust manifold or other hot spots in the engine compartment. This is true even when high-temperature elastomers, such as silicone are used. In such applications, the temperature capability of an elastomeric boot can be increased by the use of a metal heat shield which dissipates heat from any close hot spots in the engine compartment and tends to uniformly distribute the heat around the elastomeric boot. These metal heat shields also contact the metal bases of spark plug to transfer heat to the massive and cooler engine block to enhance heat shielding effectiveness.

Examples of such heat shields are shown in US Patent Nos 4,497,532; 4,671,586 and 5,163,838, all of which are assigned to the applicants. The heat shields disclosed in these US patents are cylindrical and surround the linear elastomeric boots containing a spark plug connector terminal and they are electrically grounded to a metal shell of the spark plug. In these heat shields, the ignition cable boots are merely inserted into the heat shield.

It is also known to provide metal shields which are L-shaped tubes or elbows, such as those shown in US Patent Nos 1,988,859, and 2,301,572. These metal elbow heat shields cannot, however, be used with a preformed L-shape elastomeric boot since such a boot could not be inserted into such an elbow.

A heat-shielded spark plug boot assembly according to the present invention is characterised by the features specified in the characterising portion of claim 1.

Accordingly, it is a broad object of the present invention to provide a new and improved stamped, sheet-metal heat shield for a preformed L-shaped ignition cable boot for a spark plug. It is a further object to provide such a heat shield which can be connected by snap-fitting to a preformed L-shaped boot, which is of an economical and simple construction, and which can be readily made from stamped metal stock.

In accordance with the provisions of the present invention, the heat shield is stamped from aluminium sheet metal and then is bent and formed to provide a pair of spaced-apart, generally parallel L-shaped sides and a back side having a semi-circular upper end indented slightly inwardly. The sides at their upper ends are then rolled towards and into engagement with each other to form a semi-circle and a longitudinal seam at their free edges, and with the upper ends thereof engaging the semi-circular upper end of the back. The upper end of one side has a tab whose free end is wider than its base and the upper end of the other side has a complementary-shaped recess whose bottom is wider than its mouth so that the tab will be received in the recess when the upper ends of the two sides are rolled towards each other to form a semi-circle, so as to interlock the two sides together and prevent separation thereof. The elastomeric boot is connected to the heat shield by merely pressing the same between the two sides and into engagement with the back and the upper ends of the sides. The boot is retained within the heat shield by a pair of indents in the sides of the heat shield after the cable receiving end of the L-shaped boot is deflected and pressed therepast and into engagement with the back of the heat shield.

The heat shield also has a pair of forwardly-extending ears for engaging a metal shell of a spark plug to provide a ground path and a heat-conductive path. In addition, the spark plug connector assembly, preferably employs a dielectric material which surrounds the L-shaped boot to increase the dielectric strength of the assembly sufficiently to prevent troublesome electrical discharges, such as corona discharges, through the elastomeric boot whilst avoiding any need for increasing the thickness of the elastomeric boot.

The present invention further resides in various novel constructions and arrangement of parts, and further objects, novel characteristics and advantages of the present invention will be apparent to those skilled in the art to which it relates and from the following detailed description of the illustrated, preferred embodiment thereof made with reference to the accompanying drawings forming a part of this specification and in which similar reference numerals are employed to designate corresponding

parts throughout the several views, and in which:

Figure 1 is a bottom end view of a heat-shielded spark plug boot assembly for a spark plug connector in accordance with the preferred embodiment of the present invention;

Figure 2 is a cross-sectional view of the heat-shielded spark plug boot assembly of Figure 1, taken approximately along lines 2-2 of Figure 1, but showing the spark plug boot assembly connected to a spark plug which in turn is connected to an engine block;

Figure 3 is a side elevational view of a heat shield of the heat-shielded spark plug boot assembly of Figure 1;

Figure 4 is an end view of the heat shield of Figure 3 looking in the direction of the arrows 4-4 of Figure 3;

Figure 5 is an end view of the heat shield shown in Figure 3 taken at right angles to the view in Figure 4; and

Figure 6 is a plan view of the heat shield as it is stamped from flat metal stock and prior to its being folded to the shape shown in Figures 1-5.

Referring to Figures 1 and 2 of the drawings, a heat-shielded spark plug boot assembly 10 is thereshown. The heat-shielded spark plug boot assembly 10 comprises, in general, an elastomeric boot 12, an ignition cable 14, a socket terminal 16, a dielectric barrier 18 and a heat shield 20 surrounding the boot 12. The heat-shielded spark plug assembly 10 is adapted to be connected to a spark plug 22 which in turn is threadably secured to an engine block 24.

The ignition cable 14 is a conventional high energy T.V.R.S. (television-radio-suppression cable) which has a non-metallic conductive core and a high-temperature silicone insulation jacket. The socket terminal 16 is a metal terminal and has one end 16a which is attached to the end of the ignition cable 14 by a conventional strip and fold technique. The terminal 16 at its other end 16b is at right angles to the end 16a and can be of any suitable or conventional socket design for connection to a conventional stud terminal 26 of the spark plug 22.

The spark plug 22 is likewise of a conventional design and standard configuration. It comprises the stud terminal 26 which plugs into the socket terminal end 16b of the terminal 16, a ceramic insulator 28 and a metal base 30 having a hexagonal head 32 and a threaded shank 34 which is threadably connected to a threaded opening 24a in the engine block 24.

As best shown in Figure 2, the elastomeric spark plug boot 12 is preformed so as to be L-shaped, that is, it is a 90° or right-angle elastomeric boot. The boot 12 has a cable end portion 40, an intermediate cavity portion 42 and a seal end portion 44. The elastomeric boot 12 is hollow throughout and the cable end portion 40 has an opening 40a which is sized so as to sealingly engage around the outer silicone jacket of the ignition cable 14. The intermediate cavity portion 42 is L-shaped and somewhat larger than the opening 40a to provide room for the right-angled socket terminal 16 attached to the end of the ignition cable 14. The seal end portion 44 has an opening 44a which is sized to sealingly engage around the ceramic insulator 28 of the spark plug 22, as shown in Figure 2.

The heat shield 20 is made from aluminium sheet-metal stock. The heat shield 20 is initially stamped to the configuration shown in Figure 6. The flat stamping is then folded, bent and rolled to the final shape of the heat shield 20, as shown in Figures 1-5. The heat shield 20 comprises a pair of inverted L-shaped sides 50, 52 as viewed in side elevation as shown in Figure 3. The sides extend generally parallel to each other and are planar. The heat shield also has a top side 54 extending transversely of the sides 50, 52. The top side 54 has an upper end 56 which is indented inwardly slightly as indicated by reference numeral 58 in Figure 3, and for a reason to be hereinafter more fully described. The upper end 56 of the back 54 is planar, semi-circular in shape and has an outer edge surface 60. The sides 50, 52 at the upper end portions 50a, 52a thereof are rolled towards each other to form a semi-circle, as indicated by reference numeral 70 in Figure 1. These upper end portions 50a, 52a of the sides 50, 52 engage and follow the contour of the semi-circular edge surface 60 of the upper end 56 of the top side 54 when rolled towards each other. The edge surface 60 thus prevents the upper ends 50a, 52a from being rolled too far towards one another. The upper ends 50a, 52a engage each other to form a longitudinal seam 72.

The upper ends 50a, 52a of the sides 50, 52 when rolled into engagement with each other are interlocked via a tab 80 and a recess 82. That is, the side 50 has a tab 80 extending transversely of the seam 72. The tab 80 at its free end 80a is wider than at its base 80b. The upper end 52a of the side 52 has a complementary-shaped recess 82 therein whose bottom 82a is wider than its mouth 82b. When the upper ends 50a, 52a are rolled towards each other, the tab 80 is rolled into the recess 82 to interlock the two sides 50, 52 together and to prevent them from being pulled apart or separated. It should be noted that, as a result of the engagement of the upper ends 50a, 52a with the semi-circular surface 60 of the upper end 56 of the top side 54, and the engagement between the upper ends 50a, 52a at the seam 72, that a substantially tight enclosure is formed. The sides 50, 52, top side 54 and the upper ends 50a,

52a thus form a three-sided enclosure which forms the heat shield 20, the heat shield 20 having an open side 20a for receiving the L-shaped elastomeric boot 12. The heat shield 20 surrounds the elastomeric boot 12 for approximately 270° of its circumference.

The elastomeric boot 12 is attached to the heat shield 20 by merely pressing the same into the heat shield 20 from the open side 20a. To retain the elastomeric boot within the heat shield, the sides 50, 52 are provided with a pair of indents 90. As best shown in Figure 1, the transverse distance T between the indents 90 is less than the diameter of the cable-receiving end portion 40 of the elastomeric boot 12. Thus, when the elastomeric boot 12 is inserted into the heat shield 20 from the open side 20a, the elastomeric cable receiving end portion 40 of the elastomeric boot 12 will deflect and then snap behind the indents 90. The indents 90 retain and hold the boot 12 in place in the heat shield 20.

Preferably, the heat shield of the elastomeric boot assembly 10 would also include a dielectric barrier 18. The dielectric barrier 18, as illustrated in Figure 1, could be a thin, high-temperature dielectric material which extends around the sides and back of the elastomeric boot 20 throughout its length and extent and, preferably, somewhat past the seal end portion 44, as shown in Figure 2. The dielectric material could be a laminate consisting of an inner Kapton film layer of 0.08 mm (3 mils) thickness and an outer Nomex paper layer of 0.05 mm (2 mils) thickness. Kapton is a trademark for the polyimide films of DuPont, while Nomex is DuPont's trademark for heat-resistant aromatic polyamide fibres.

It is also possible to use other high-temperature dielectric films such as Teflon and Mylar. Teflon is a DuPont trademark for polytetrofluoroethylene whilst Mylar is a DuPont trademark for its polyester.

It is likewise possible to use spray and powder coatings on the inside surfaces of the heat shield 20, such as Ryton, epoxy resin, silicone resin, fluoropolymers and enamels which can be applied either to a paper layer or directly onto portions of the heat shield 20 whilst it is still a flat blank, as shown in Figure 6, prior to its being bent and formed. Applying such a coating or film to the flat blank, as shown in Figure 6, would be an easy way to provide a dielectric barrier for three sides of the elastomeric boot 12.

The metal heat shield also includes a pair of arcuate, downwardly-projecting ears 100 for engagement with the hexagonal head 32 of the metal shell 30 of the spark plug 22. This engagement provides both a heat-conductive path to the engine block 24 and also a ground path for any electrical discharges. Thus, conduction of corona from the elastomeric boot 12 to the metal heat shield 20 by a path around the dielectric barrier 18 is significant because corona discharge through the dielectric barrier can cause a dramatic loss in dielectric strength of the dielectric barrier 18.

From the foregoing, it should be apparent that a novel, simple, inexpensive heat shield 20 for a preformed L-shaped elastomeric boot 12 has been provided. In addition, the elastomeric boot can be readily attached by snap fitting to the heat shield 20 which reduces assembly time.

Although the illustrated embodiment of the invention hereof has been described in great detail, it should be apparent that certain modifications, changes and adaptations may be made in the illustrated embodiment which are within the scope of the present invention as claimed within the following claims.

The disclosures in United States patent application no. 104,697, from which this application claims priority, and in the abstract accompanying this application are incorporated herein by reference.

Claims

1. A heat-shielded, spark plug boot assembly (10) for an ignition cable connector, said assembly (10) comprising: an L-shaped, tubular elastomeric boot (12) having a cable end portion (40) for receiving an ignition cable (14), a seal end portion (44) for receiving a spark plug (22) and sealing around its outer insulator part (28), and an intermediate cavity portion (42) for housing a terminal (16) having one end (16a) secured to one end of the ignition cable and its other end (16b) connectable to a terminal (26) on said spark plug (22); and a heat shield (20) surrounding said elastomeric boot (12), characterised in that said heat shield (20) is an L-shaped heat shield (20) mounted on said elastomeric boot (12) and which surrounds said elastomeric boot (12) for approximately 270° of its circumference, and said heat shield (20) is stamped from flat sheet-metal stock and is then bent and formed to provide a pair of spaced-apart, generally parallel L-shaped sides (50,52) and a top side (54) between the sides (50,52) which has a semi-circular shaped upper end (56); said sides (50,52) at upper end portions (50a,52a) thereof are rolled towards and into engagement with each other to conform to said semi-circular shaped upper end (56) and to form a longitudinal seam (72) at the adjacent edges thereof; said upper end portion (50a) of one side (50) has a tab (80) whose free end (80a) is wider than its base (80b) and

the upper end portion (52a) of the other side (52) has a complementary-shaped recess (82) whose bottom (82a) is wider than its mouth (82b); and said tab (80) is received within said recess (82) when said upper end portions (50a,52a) of said sides (50,52) are rolled towards each other to conform to said semi-circular shaped upper end (56), so as to lock the sides (50,52) together.

2. A heat-shielded, spark plug boot assembly (10) according to claim 1, in which said top side (54) extends transversely between said sides (50,52); said semi-circular shaped upper end (56) is indented to define a planar semi-circular area spaced slightly inwardly from the rest of said top side (54); said upper end portions (50a,52a) engage said semi-circular shaped upper end (56) of said top side (54) when in engagement with each other; and said elastomeric boot (12) is connected to said heat shield (20) by the insertion of the elastomeric boot (12) into the heat shield (20) from an open side thereof.

3. A heat-shielded, spark plug boot assembly (10) according to claim 2, in which said sides (50,52) have indents (90) formed therein for retaining said boot (12) within said heat shield (20), said indents (90) being spaced apart from one another by a distance (T) which is less than an adjacent diameter of the boot (12) so that the boot (12) is snap-fitted past the indents (90) on the sides (50,52) upon insertion of the boot (12) into the heat shield (20).

4. A heat-shielded, spark plug boot assembly (10) according to any one of claims 1 to 3, in which the L-shaped heat shield (20) mounted on said elastomeric boot (12) extends past the seal end portion (44) of the elastomeric boot (12) for engaging a ground member (32) on said spark plug (22).

5. A heat-shielded, spark plug boot assembly (10) according to claim 4, in which the assembly (10) includes a thin dielectric barrier (18) located between the boot (12) and the heat shield (20).

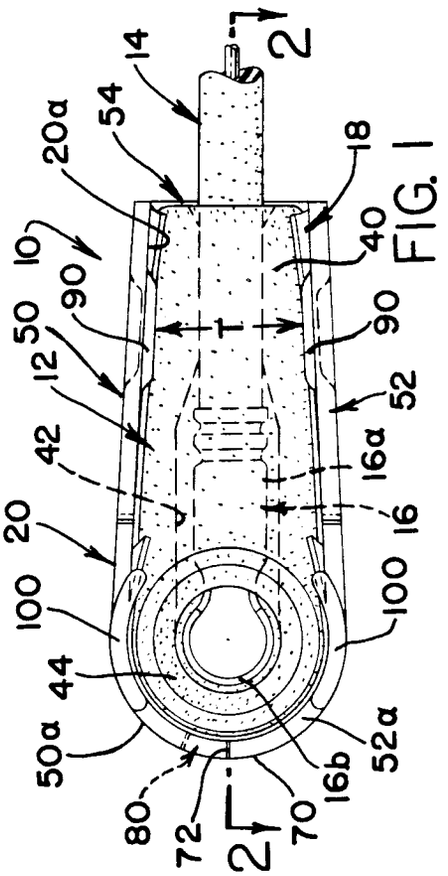

FIG. 1

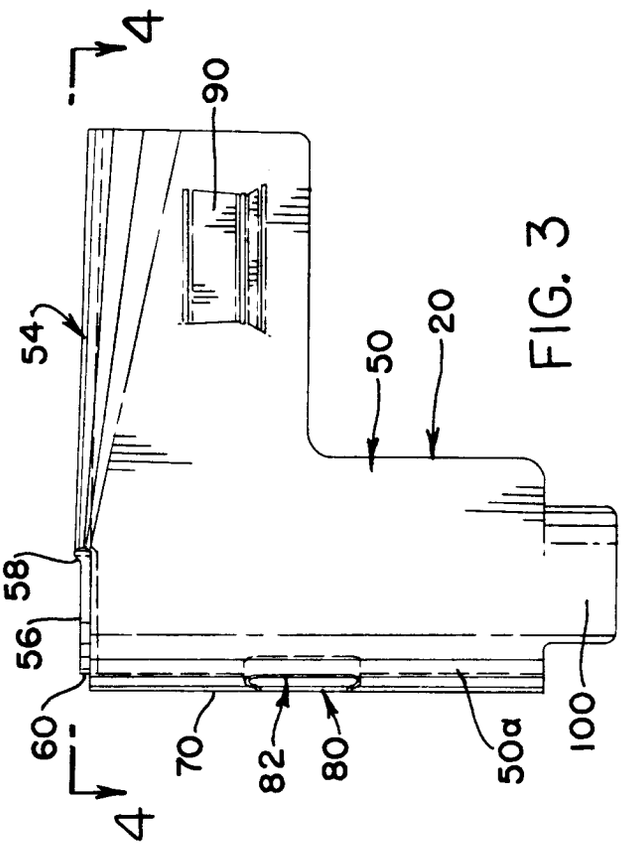

FIG. 3

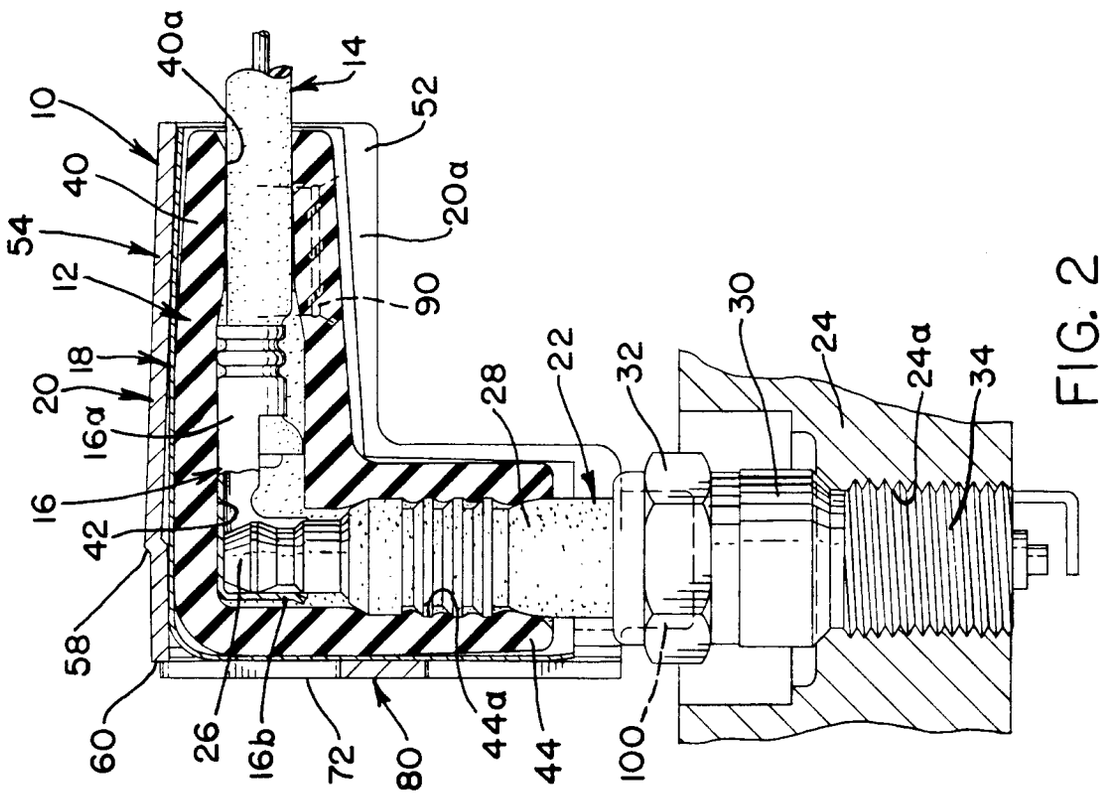

FIG. 2

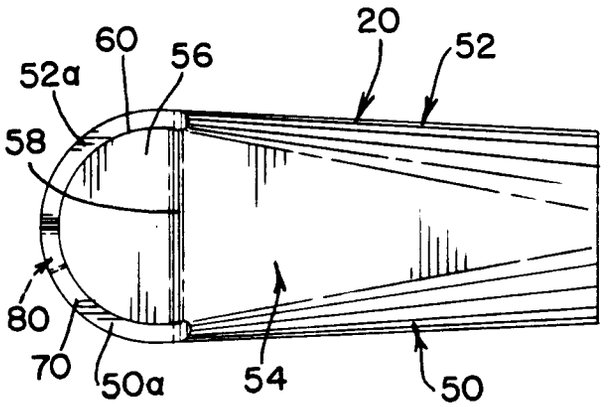

FIG. 4

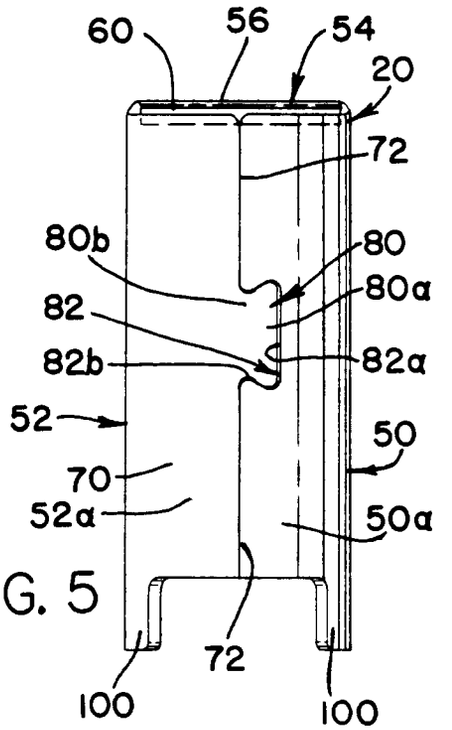

FIG. 5

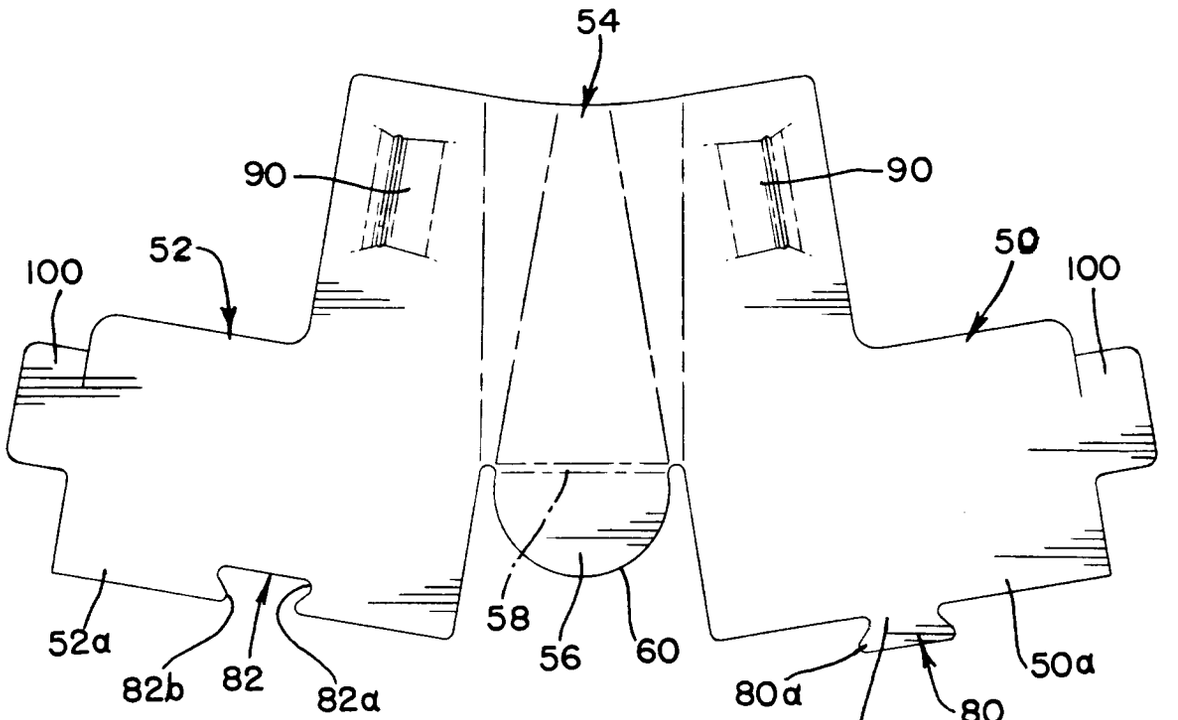

FIG. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 94 20 1983

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	US-A-3 965 879 (FITZNER) * column 3, line 1 - line 20 * * column 5, line 40 - column 6, line 12; figure 1 *	1	H01T13/06 H01T13/16
D,A	US-A-1 988 859 (SHUMAKER) * claim 1; figure 2 *	1	
D,A	US-A-2 301 572 (NOWOSIELSKI) * page 2, left column, line 49 - right column, line 2; figure 1 *	1	
A	US-A-2 361 699 (MALCZEWSKI)		
A	FR-A-1 007 431 (LECLUSE)		

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

H01T

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	15 November 1994	Bijn, E

CATEGORY OF CITED DOCUMENTS

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